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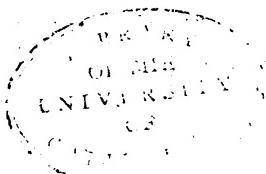
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APR 17 1916

California Reclamation Co., Ltd.

FLOOD CONTROL AND RECLAMATION IN CALIFORNIA



CALIFORNIA
STATE PRINTING OFFICE
1916



Flood Control and Reclamation in California

BY

V. S. McCLATCHY

President State Reclamation Board



Paper presented at annual meeting of the National Drainage Congress,
in Cairo, Ill., January 20, 1916, with map, illustrating
Sacramento River Flood Control Project.

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FLOOD CONTROL AND RECLAMATION IN CALIFORNIA.

✓ Flood control in California, and reclamation dependent on that flood control, are subjects fraught with unusual interest because of the variety of problems presented, the solutions offered, or in process of incubation, and the manner in which the projects are being financed and carried out.

With one exception the great flood control problems of the State of California are entirely devoid of interstate and international complications. Her two great navigable waterways rise and flow to the sea entirely within her borders, as do all minor streams which involve in any way problems of this nature. ✓ Navigation interests are seriously concerned in the solution of two of these problems and in a minor way in a third. Reclamation or conservation interests are concerned in all of them. Irrigation, which in California is considered of first importance, is solicitous that the solutions offered shall always advance and not hinder that interest. Irrigation has been consequently very much disappointed to find that, because of conditions, physical and economic, storage reservoirs can be used in only a minor way for flood control in the State.

Because of the purely intra-State character of all save one of these problems, they will prove very much easier of final solution than if presented in other sections of the United States. California is free to handle them as she may desire, having regard only for such rights and interests as the United States may have in navigation and conservation. The State, too, is attempting to treat these problems in a broad and efficient manner, with every hope for speedy and successful results. What she has done and is doing in co-operation with the United States as to the Sacramento River will be explained later on. In addition—and to deal in a comprehensive way with the entire subject—the Legislature of 1915 named a State Water Problems Conference of seventeen, including, ex-officio, the Lieutenant Governor, the heads of various State Commissions, and Legislative committees having to do with water and its uses and connected interests, with instructions to report in November, 1916, "its recommendations as to a unified policy with reference to irri-

gation, reclamation, water storage, flood control, municipalities and drainage, with due regard to the needs of water power, mining and navigation." This Conference has already held a number of public hearings, at which experts and interested parties have furnished valuable data and suggestions on the various subjects referred to.

Problem of the Colorado.

In the extreme southern end of the State there is the problem of the Colorado which involves interstate and international complications. That river forms, for nearly 200 miles, the boundary line between California and Arizona, while Nevada, Utah and Colorado also have interests and rights in the stream. Our neighbor on the south, Mexico, is interested because the river forms for seventeen miles the boundary line between her territory and the American State of Arizona, and then flows for eighty miles over Mexican soil to the Gulf of California; and she has treaty obligations with the United States under which its navigability may not be impaired.

Prior to the eighties the Colorado was used to a considerable extent for transportation by light draft boats, but such use steadily decreased after the building of the Santa Fe and Southern Pacific railroads, which cross the stream respectively at Needles and Yuma. In 1902 the river was practically closed to navigation above Yuma by Congressional action in permitting construction, for purposes of the United States Reclamation Service's Yuma project, of the Laguna dam, with no provision for passing boats.

Mexico jealously guards, from American aggression at least, the navigability of her section of the stream, and strenuously objects, under the treaty, to the diversion of water, from any point on the Colorado or its tributaries, which may impair navigability on the eighty miles within her borders. She insists that diversions of the kind may not be made without revision of the treaty, and in the event of such revision she has indicated her intention of securing such subdivision of the waters as will permit irrigation of Mexican lands.

The Colorado is the sole source from which can be obtained water

to irrigate the wonderful Imperial Valley, in the southeastern part of California, and the Yuma Valley, partly in California and partly in Arizona. The headworks of the Imperial Valley Irrigation system is on American soil close to the international boundary, but in order to avoid a peculiar sandhill formation, the water must be carried by ditch many miles over Mexican soil before it crosses the border again for use in the valley.

The Colorado, too, is the only source from which the counties of San Bernardino, Riverside and San Diego in California can hope to secure water under economic conditions for irrigating several hundred thousand acres of desert land in the eastern portion of such counties.

The Colorado wanders about its lower reaches to such an extent that it offers a constant menace to this portion of California, while the points of breach are on Mexican soil and must be safeguarded, under Mexican tolerance, by American interests. Even now, the levee construction and lines must be changed from time to time.

In the year 1905 there occurred, about three miles below the California-Mexico line, the break which diverted all the waters of the Colorado into the Salton Sink and created the Salton Sea, with a maximum depth of seventy-six feet, a length of fifty miles and a width of ten to fifteen miles, a total water area of 445 square miles. That sea is still there, though in steadily decreasing proportions. The break threatened inundation of the entire Imperial Valley and permanent blocking of the Southern Pacific route. Because of this latter danger the Southern Pacific Company stopped the crevasse and completed, in 1907, a line of protective levees, the whole involving a deal of engineering skill and an outlay of \$2,000,000.

H. T. Cory, an engineer, who was prominently identified with that work, says that:

"The problems of the Colorado are in very large measure interstate and international, rather than engineering. They include an adjustment and division of the water not only between several of the United States, but with Mexico, while river control must be done almost wholly on Mexican soil and by American interests."

The Problem of Los Angeles.

In Los Angeles County a very serious problem is presented by a few streams, dry in Summer, but which in Winter, because of the proximity of the mountains to the sea, become raging torrents, carrying away acres of orchards and homes, and deposit-

ing the debris at the mouth of the Los Angeles River in the harbor of Los Angeles. It is estimated that Los Angeles County suffered two years ago over \$10,000,000 damage through floods of this nature in the Santa Ana, Los Angeles and San Gabriel Rivers.

A commission of able engineers, created by the County of Los Angeles, is making careful study of the problems involved. From reports already published the commission appears to have reached the conclusion that a large portion of these extreme floods must be wasted in the sea. It is proposed to divert them through the San Gabriel River to an ocean outlet remote from the harbor, and thus avoid injury thereto.

Because of the great value placed upon water for irrigation in Southern California, every effort has been made to devise a plan which would store these floods in reservoirs, the amount which will be so conserved is said to be comparatively small, due to physical and economic conditions. Such reservoirs as may be recommended are to be supplemented by check and saturation dams in headwater canyons, preventing wash and inducing the soil to take up some of the flow. Lower down the floods will be spread over gravel beds through which a certain portion will sink and find its way by underground channels to the valleys, where it will raise the water table and be available for pumping. What cannot be cared for in any of these ways must be carried in safeguarded channels to the sea.

It is proposed that the lands in the county benefited by the flood control project shall pay the expense thereof, with some assistance from the State. While the plan has not been finally determined in its various details, it is estimated that the expense will exceed \$15,000,000.

Problem of the San Joaquin.

In the upper portion of the State there is a great interior valley extending 400 miles from Red Bluff, in the north, where the Sierra Nevada and Coast Range Mountains meet, to a point south of Bakersfield, where the Tehachapi Mountains form the northern boundary of Southern California. This valley is distinguished in its two sections by two names: The southern portion is known as the San Joaquin Valley, taking its name from the San Joaquin River which flows north, draining with its tributaries 7,000,000 acres of rich valley lands and the contiguous mountain slopes. The northern portion is called the Sacramento Valley, the Sacramento River flowing

south through it and draining 3,000,000 acres of valley land, and the mountain slopes adjoining. The two rivers empty, side by side, through a common delta, into an arm of San Francisco Bay, sixty miles north of the port.

Each of these valleys has its problem in flood control and reclamation. That of the San Joaquin is similar in many phases to that of the Sacramento, though its maximum flood volume is only one-sixth as great. Through joint action between Federal and State Governments, complete surveys of the San Joaquin Valley are now being brought to completion, and, on study of data prepared therefrom, the United States engineers, comprising the California Debris Commission and the State Engineering Department, will devise a comprehensive plan of flood control which can be adopted and put into effective operation through State machinery already provided.

The Sacramento River Problem.

The study of the Sacramento River problem furnishes perhaps most valuable matter for consideration to the student of flood control and reclamation, because it presents, first, a unique problem; next, the accepted solution of that problem; and finally the rapid progress of work on the project under a striking example of Federal and State co-operation.

First, as to the problem: The Sacramento River is, in amount of maximum flood, the fourth greatest river in the United States, being exceeded only by the Mississippi below its junction with the Missouri, by the Ohio, and by the Columbia; while in proportion to the square miles of territory drained, its flood is over five times as great as that of any river in the Union. Its maximum flood discharge is usually estimated at 660,000 second feet, though a total peak or crest flow into the valley of 835,000 second feet has been recorded. The varying lengths of the tributaries usually insure passage of the crest of the American where it reaches the Sacramento at Sacramento City, before the crest of either the Feather, or the upper Sacramento comes down.

Compare this enormous flood with the extreme capacity of the river channel from Sacramento City to the river's mouth, sixty-four miles, which is but 110,000 second feet. Above the mouth of the Feather River, where the maximum flood in the Sacramento River would exceed 200,000 second feet, there is a twenty-mile stretch of channel whose extreme capacity is but 35,000 second feet.

The problem is further complicated by the presence in the river channel and in the Feather and American (its main tributaries) of immense deposits of mining debris, the results of hydraulic mining prosecuted in the earlier history of the State under Federal toleration. These deposits moved with each freshet and had destroyed in great part the navigability of the Feather and seriously impaired navigation on the Sacramento.

Reclamation itself, as conducted under State law up to 1911, had further complicated the situation. Every individual landowner or reclamation district was free, in the reclamation of his own land, to protect himself by levee against the common enemy, flood waters, even if in so doing he forced them upon his neighbor, and provided only he did not force drainage waters on that neighbor. Naturally every reclamation project, by withdrawing a certain acreage from the basin reservoir capacity in flood season, raised the flood plane, and in time each man found that, while he was supposedly leveeing against his neighbor, he was in reality hastening the day when he himself must raise his levees or be inundated. The flood plane, with the same maximum flood, raised eight feet in forty years at Sacramento City, and it was plain that the time was approaching when the cost of maintaining levees which would withstand floods must exceed the value of lands and improvements, and that eventually in many places, levee protection, at any cost, would become impracticable. In addition, every man with a river frontage was in a measure dependent for his own safety on the vigilance and enterprise of his neighbor, whose levees joined, and against whose carelessness or indifference he could not guard.

Solution of the Problem.

The Federal Act of 1893 created the California Debris Commission, composed of three United States army engineers, with instructions to devise a plan for controlling the deposits of mining debris and restoring to the Sacramento River the degree of navigability it possessed in 1860. After seventeen years the final plan was offered in the report of the Chief of Engineers of 1910, House Document No. 81, Sixty-second Congress, First Session, and afterwards modified, as to methods of financing only, by the report of 1913, House Document No. 5, Sixty-third Congress, First Session. In the meanwhile much of the debris deposits in the upper streams had been held back through the construction of

permanent dams. The plan, while formally approved by the Rivers and Harbors Committee and the Commerce Committee of the Senate and passed by the lower House in the Rivers and Harbors Bill of 1914, failed, through filibuster, in the Senate. It is not yet, therefore, in the category of approved projects. The plan has been formally adopted, however, by the State of California, and is progressing rapidly to completion through joint action, as hereafter explained.

The plan contemplates retaining within the river channel all the waters which it can safely carry, by the maintenance of strong levees on or near the river banks; and caring for the excess flow in flood season by conducting it over easements, or weirs, and through by-passes (strips of land protected on each side by levee) to a junction with the river, fifteen miles above its mouth, whence a widened and deepened channel will discharge the entire floods into the upper arm of San Francisco Bay. The sills of the weirs fix automatically a flood plane for each station of the river, beyond which the water cannot rise in the channel, while constant improvement of the channel itself will be secured by the scouring of the current and by dredging operations necessary to maintain levees. The plan calls for four weirs, located, respectively, two in Yolo County, one in Sutter, and one in Butte, and ninety miles of by-passes varying in width from 1,000 to 14,000 feet. The section of channel at the river's mouth is to be widened to 3,000 feet (about four times the present width in places) and deepend to thirty-five feet at extreme flood.

The report of the Chief of Engineers indicates that this is the only plan, economically feasible, which will secure control of floods, restore navigation, care for debris deposits and allow permanent reclamation, and that the interests named are so interwoven on this stream that they cannot be separately treated.

Apportionment of Work and Expense

The plan provides that the Federal Engineers shall construct the weirs and enlarge the river's mouth, the estimated expense thereof, \$12,500,000, to be paid, half and half, by Congress and the State. The construction of river levees (502 miles), of the by-pass levees, (180 miles), and purchase of rights-of-way (about 85,000 acres) are to be under direction of the State, and to be paid for by the lands, benefited through the fact that completion of the proj-

ect will make permanent reclamation of these lands possible. The original estimates indicated a cost of about \$21,000,000 for the elements of the project to be paid for by the landowners. Improved standards of levee since adopted and the necessity for extensive revetment will increase the cost to perhaps \$30,000,000.

Under this plan the State of California and the landowners, therefore, will pay, together, about six-sevenths, and the United States about one-seventh, of the cost of a project which, while of great value to reclamation and flood control, is also indispensable for preservation of the navigability of the two great waterways of the State. This is an unusual, if not a unique, instance of State co-operation.

Storage Reservoirs and Major Dikes Rejected.

The Engineers' reports reject storage reservoirs as a solution of the problem because, (1) the available sites would care for only a fraction of the flood; (2) the cost of storage for the small quantity of flood which could be so handled would be from two to ten times as great as the cost of caring for the same volume of flood by the by-pass system.

While there is, on paper, an apparently large storage capacity in the Sierra Nevada Mountains, investigation shows that the greater portion thereof is not available for flood control of the Sacramento for one or more of the following reasons.

- (a) It is above the source of flood waters.
- (b) It is far in excess of the quantity of the season's flood which can drain to it.
- (c) It will be filled, not by flood waters in time of river flood, but by melted snow after the danger of river flood has passed.

For instance, the Big Meadows reservoir holding the drainage caught by a small scetion of one fork of the Feather River, with a capacity of over 500,000 acre feet, is practically worthless for flood control of the Sacramento River.

While, for reasons indicated, the plan rejected storage reservoirs, it conceded their value as additional factors of safety to the extent of their flood capacity, when the interests of irrigation or power justify their construction; and the plan was so arranged that they will fit in.

There was also abandoned a plan recommended in 1904, under which the flood water would be confined to the river through a system of minor and major levees or dikes, the

first near the river bank and the latter 100, 200 or 300 yards back therefrom. Under this plan, as the floods increased beyond the capacity of the river channel to accommodate them, they would overflow the strip of land adjoining, between the bank and the major levee. This plan obtains in Holland. Even those who proposed the plan, however, afterwards conceded that it was entirely inadequate to handle such floods as came, subsequently, in 1907 and 1909. There were other grave practical objections to this plan.

State Legislation.

The plan recommended by the Federal Engineers met the prompt approval of California through legislative enactment of December, 1911 (amended in May, 1913, and June, 1915), formally adopting the project and creating the State Reclamation Board, with unusual powers for carrying out the State's portion thereof. Under this law no reclamation of any kind may be inaugurated or carried on, on or near the Sacramento and San Joaquin Rivers and their tributaries, until plans therefor have first been approved by the Reclamation Board as in accord with the flood control project. The Board has the power to force construction of any unit of the project, or of any levee or reclamation work necessary for protection to districts; and to levy, apportion and collect assessments to pay for the same, throughout a district extending through fourteen counties and comprising 1,750,000 acres located below the flood plane. The Board has as its engineering advisors the State Engineering Department and the California Debris Commission of Federal Engineers, each of which is represented at each meeting and hearing of the Board, and each of which is asked to formally report upon every application made to the Board. In this way absolute co-operation in the interests of the project is secured between Nation, State and land owners.

Progress of the Project.

Notwithstanding the fact that the project has not yet received Congressional approval, progress is being steadily made in that portion under supervision of the Federal authorities and dependent upon joint appropriations from Congress and the State. This so happens because Congress approved, in 1910 (under the report of 1907), a project for caring for debris deposits by dredging operation, which project embraces certain work at the river's mouth which is part of

the comprehensive project herein described. In consequence, the work in enlarging the mouth of the river has progressed to such extent as to secure material easement in the matter of run-off of floods from the basins and river channel. There has been expended in this work already in the construction of dredges and their operation, something over a million dollars, and the plans contemplate further expenditure for the purpose of something in excess of eight million dollars.

Even as to construction of the weirs, for which (not being a part of the 1910 project) no appropriations have been made, there has been material progress through State activity. The rights of way for three of the four weirs have already been secured, and the City of Sacramento expects to actually construct, prior to January, 1917, the Sacramento weir, because of its importance in safeguarding the city and its environment from the menace of the floods of the American River. The city has voted \$500,000 in bonds for the purpose and plans for the weir are now in the hands of the Chief of Engineers for approval.

Material progress has been made in the construction of river and by-pass levees under direction of the State Reclamation Board, existing structures being utilized so far as they conform to the project, and strengthened and raised to meet the requirements of the standards established. The State's action in adopting a definite plan, in fixing the flood plane and establishing an authority to enforce compliance with a comprehensive plan, has greatly stimulated private reclamation. Capital has embarked in enterprises involving the expenditure of millions of dollars in the reclamation of large units of basin lands, the exterior protective boundaries of which are identical in instances with portions of the river and by-pass levees called for by the project. Of the 502 miles of river levees called for by the project, there are already constructed 71 miles, which are up to standard and approved; 272 miles, which are constructed but are not up to standard; 96 miles, which are in course of construction; 17 miles, which are in projects and about to be constructed, and 46 miles, for which no levee has been constructed, and for which no provision has yet been made. Of the 186 miles of by-pass levees called for by the project, there are already constructed 9.6 miles which are up to standard and approved; 23 miles which are constructed but are not up to standard;

32 miles which are in course of construction; 25.5 miles which are in projects and about to be constructed, and 96 miles for which no levee has been constructed, and for which no provision has yet been made.

Interests Dependent On the Project.

The Sacramento River flood control project, it will be seen from the facts stated, is the greatest project now in progress or under consideration in the West, and is exceeded in importance by few in the Nation. What it means in results to various interests may be thus indicated:

Upon its completion is dependent the maintenance of navigability, not only of the Sacramento River, but also of the San Joaquin, since the two rivers have a common delta and the floods of the Sacramento may affect the San Joaquin up as far as the City of Stockton, 64 miles from its mouth. The Sacramento can be made permanently navigable for light draft craft as far up as Red Bluff, 263 miles from its mouth 323 miles from the sea, while ocean freighters can land cargoes at Sacramento City during considerable portion of the year. The San Joaquin has much traffic in both freight and passengers up to Stockton, while formerly it was navigable for light draft craft for 185 miles above that point. Stockton is 124 miles from the sea, 64 miles from the river's mouth.

Upon the navigability of the two rivers depends necessarily any inland waterway system, since they must act as the main arteries therefor. Without inland waterways there will be, for the two great interior valleys, no cheap freights to tide water, no chance to transfer the products of those valleys direct from river craft into the holds of ocean-going freighters, and reach thereby the world markets. With activities

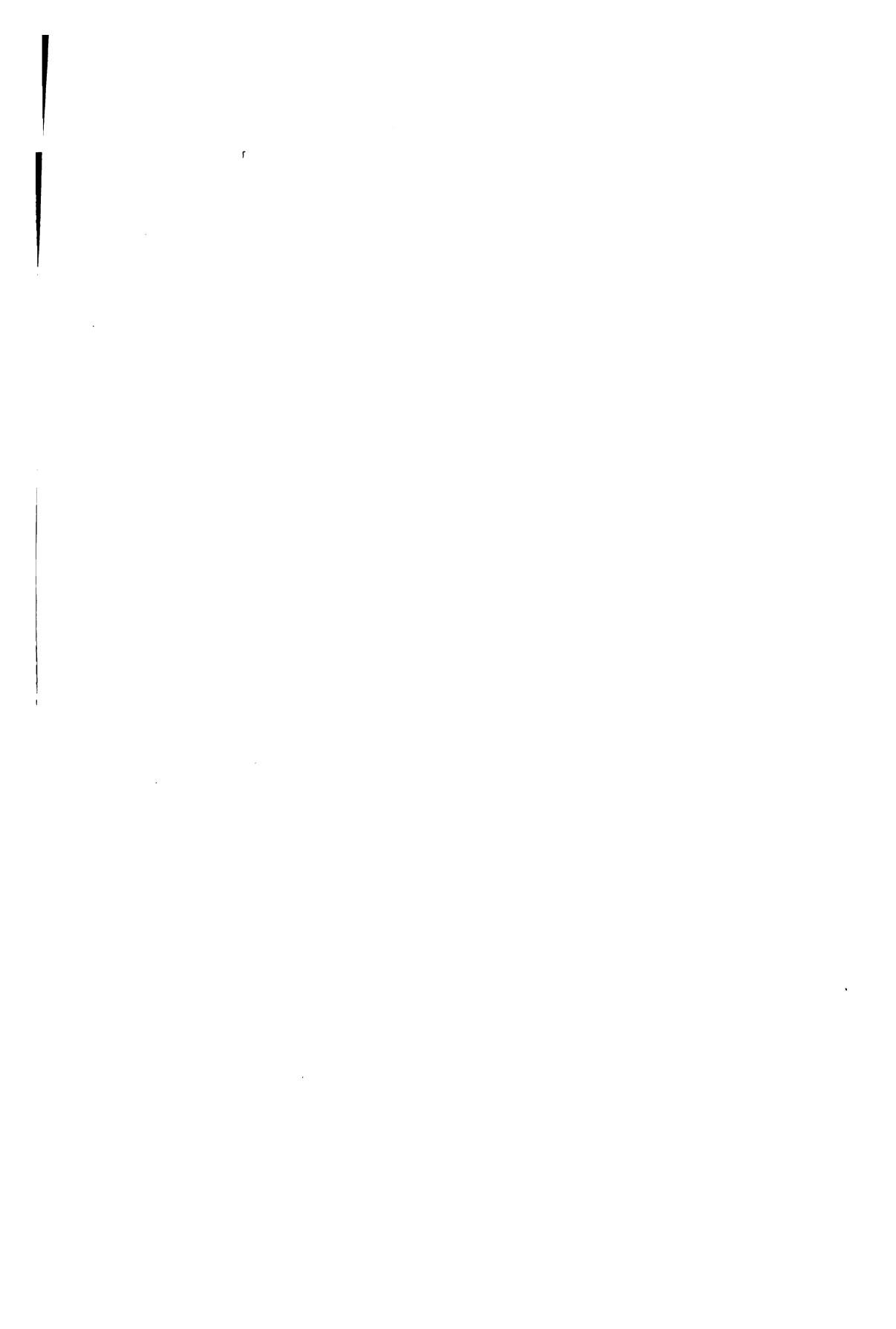
limited by local consumption there would be, therefore, no adequate development of the valleys in products, population and in wealth; and no commensurate growth of the State's commerce, which history shows will be dependent on the development of her hinterland.

The safety of life and property on 1,500,000 acres of valley lands, 250,000 acres of which lie in the San Joaquin Valley, is dependent on flood control of the Sacramento River. Included in this territory are the cities of Sacramento and Stockton.

The lands reclaimed and in process of reclamation, about 750,000 acres, are in danger each year of inundation until the project has approached completion. The annual crops on these lands have a minimum value of \$30,000,000.

The lands unreclaimed, and which must permanently remain waste unless the project be carried out, comprise about 750,000 acres. These lands, through reclamation, can add \$120,000,000 to the permanent wealth of the State and their annual crops will in time exceed \$30,000,000 in value.

There is evident in this brief statement of the facts, sufficient incentive for both Nation and State to push to early completion the Sacramento River project. The State of California prides herself upon her willingness to bear a liberal share of the burden involved, and congratulates herself upon the appreciation thereof which the Federal authorities have shown and upon the very pleasant and satisfactory relations maintained between the administrative officers of the two governments in carrying out the work. She looks hopefully forward to the time when her other great flood control problems may be solved through somewhat similar co-operation.



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